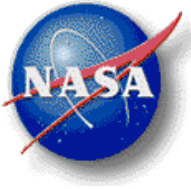


Fundamental Aeronautics

Dr. Rich Wlezien

Director (Acting), Fundamental Aeronautics
Aeronautics Research Mission Directorate



Fundamental Aeronautics

Research Thrusts

Hypersonics

Subsonics:
Rotary Wing

Subsonics:
Fixed Wing

Supersonics

Objective

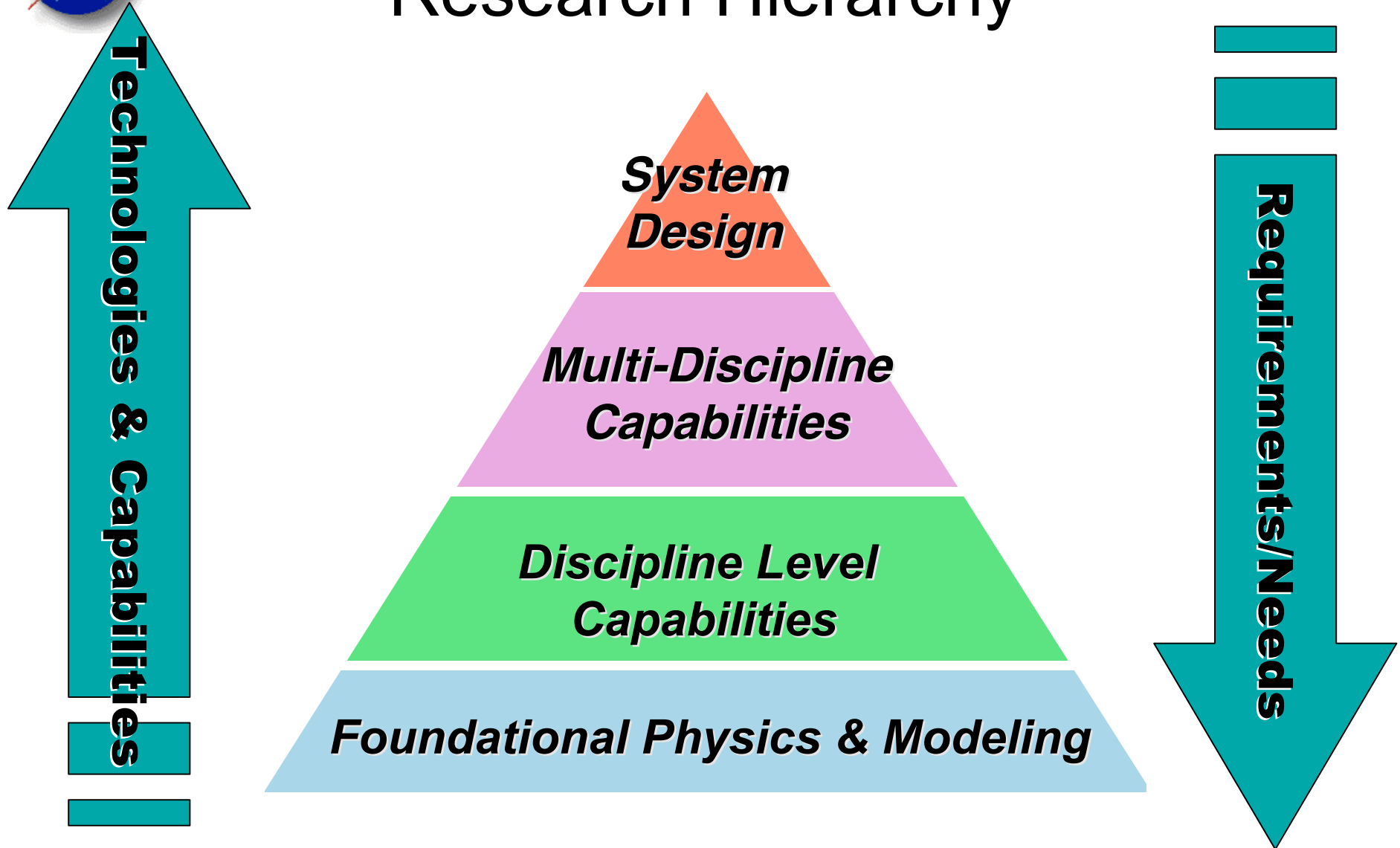
- Development of system-level, multi-disciplinary capabilities for both civilian and military applications
- Provide long-term investment in research to support and sustain expert competency in critical core areas of aeronautics technology

Results

- Technology innovation and integrated, multidisciplinary analysis tools to:
 - Provide rapid evaluation of new concepts and technology
 - Accelerate the application of new technology to a wide array of vehicles
 - Reduce the environmental impact and increase the public benefit of future aircraft: lower emissions, less noise, higher efficiency, safer operation



Research Hierarchy





Approach

Use Space Act Agreements to collaborate with industry; Establish partnerships with other Govt agencies (FAA, DoD, JPDO)

NASA development of multidisciplinary methods and technologies

NASA development of discipline-related solutions

Use NASA Research Announcements (NRAs) to solicit proposals for foundational research in areas where NASA needs to enhance its core capabilities.

Develop system-level capabilities to enable our civilian and military partners to develop revolutionary systems to meet their needs

Level 4

Integrate methods and technologies to develop multi-disciplinary solutions

Level 3

Leverage the foundational research to develop technologies and analytical tools focused on discipline-based solutions

Level 2

Conduct foundational research to further our fundamental understanding of the underlying principles

Level 1



Four-Step Planning Process

Step 1: Assess the long-term research needs and goals in Fundamental Aeronautics and establish technical roadmaps to accomplish those goals.

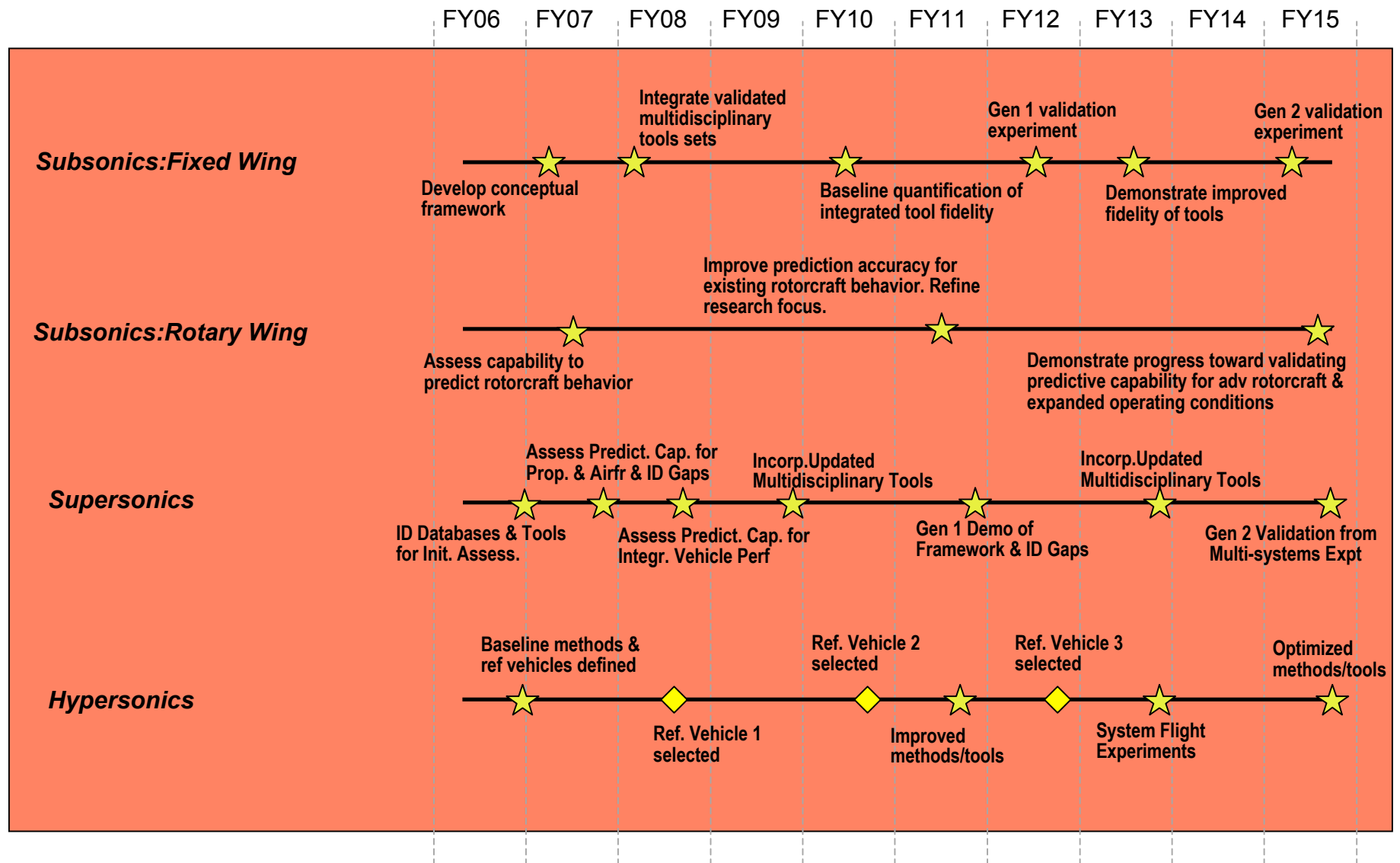
Step 2: Solicit information on key areas of interest from the external community and determine opportunities for collaboration through an RFI

Step 3: Define research proposals at the field centers

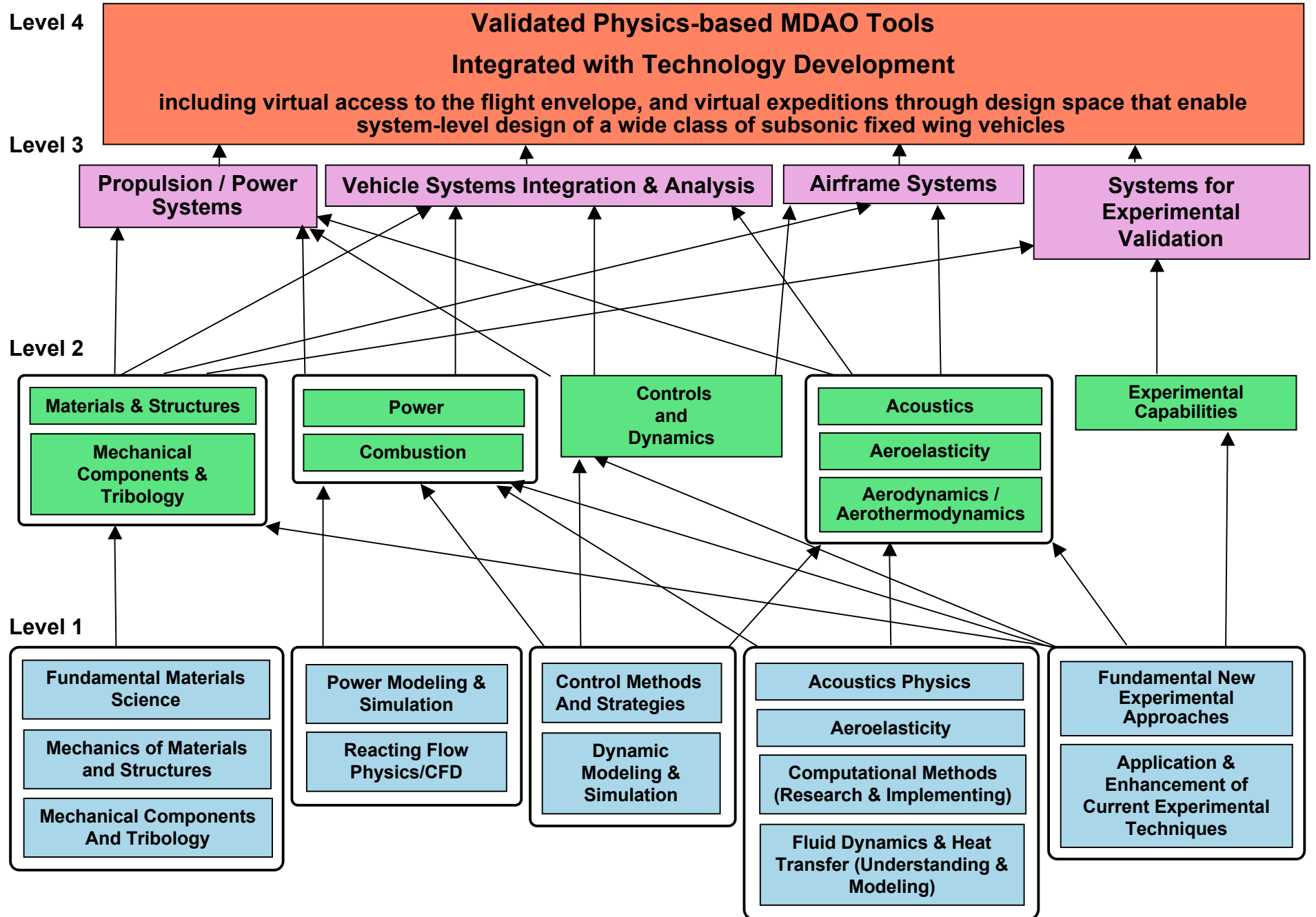
Step 4: Issue a NASA Research Announcement to solicit proposals for foundational research

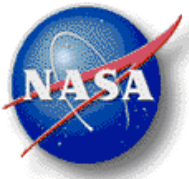


Fundamental Aeronautics Top-Level Roadmap



SUBSONICS: FIXED WING





Subsonics Fixed Wing: Research Topics

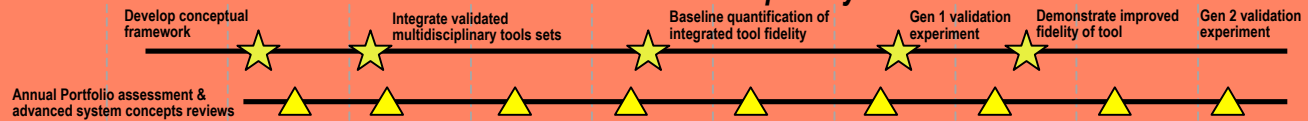
Propulsion and Power Systems	Alternative propulsion and power concepts
	Materials and structures technologies for durable, active, multi-functional propulsion and power systems
	Advanced technologies for intelligent engines, and engine icing characteristics
Vehicle Integration and Analysis	Engine and airframe noise source decomposition
	Advanced control techniques and autonomous control architectures
	Aeroelastic analysis methods
Airframe Systems	Metallic, composite, and hybrid materials and structures, analysis methods for property characterization
	Multifunctional materials and structures concepts
	Advanced materials, processing and manufacturing technologies
	Expanded design space enabled by high-lift design, edge of envelope stability and control
	Enhanced physics-based noise prediction, integrated aerodynamic, acoustic, and structural advanced analysis tool
Systems for Experimental Validation	Autonomous testbeds
	High-fidelity piloted simulations, and instrumentation with new capabilities integrated into multidisciplinary system validated with flight tests as appropriate

FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15

Subsonics:Fixed Wing

Quantified Uncertainty
Known Sensitivities

Fast and Effective PB-MDAO Capability



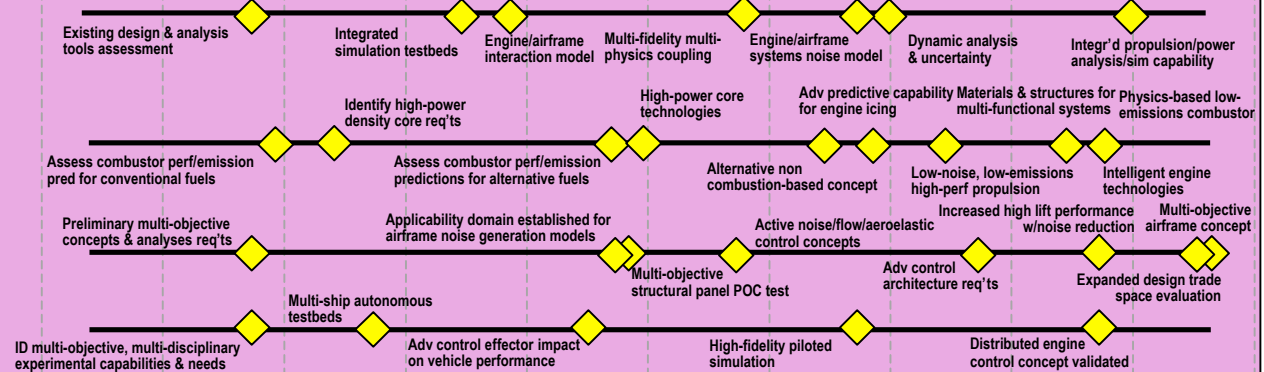
Level 4

Vehicle Systems Integration and Analysis

Propulsion/Power Systems

Airframe Systems

Systems for Experimental Validation



Level 3

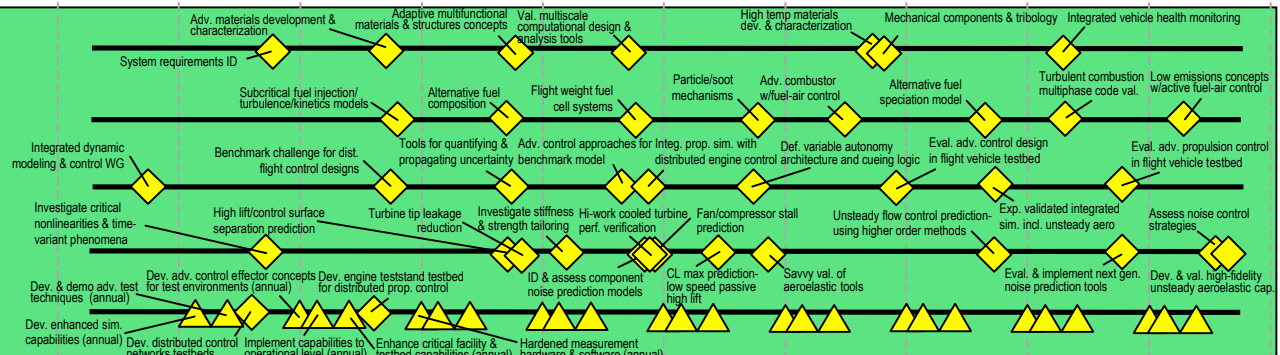
Materials and Structures & Mechanical Components and Tribology

Power and Combustion

Controls and Dynamics

Acoustics, Aeroelasticity, & Aerodynamics/Aerothermodynamics

Experimental Capabilities



Level 2

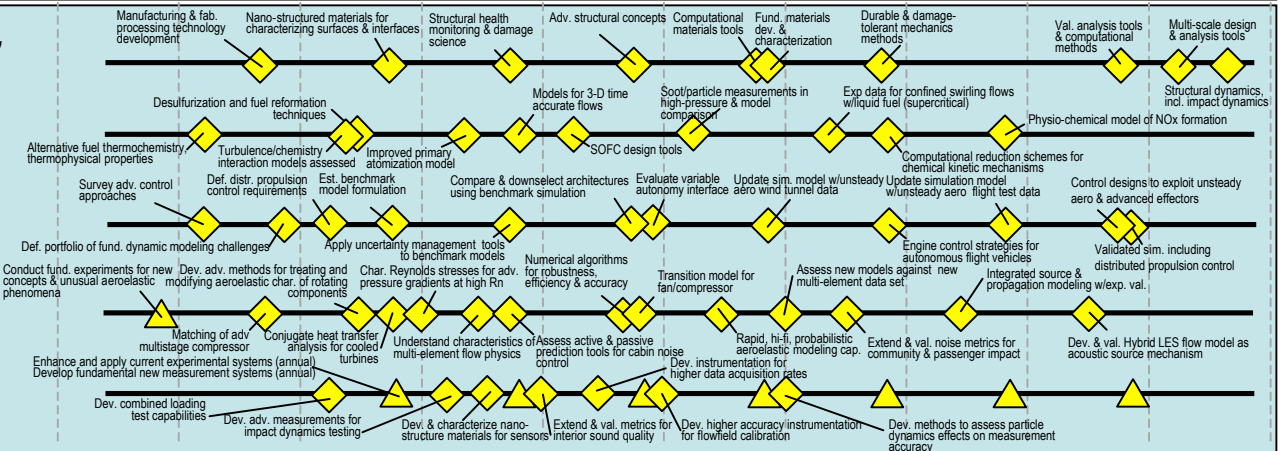
Fundamental Materials Science & Processing, Mechanics of Materials and Structures, Mechanical Components, & Tribology

Power Modeling and Simulation, & Reacting Flow Physics/CFD

Control Methods and Strategies & Dynamic Modeling and Simulation

Acoustics Physics, Computational Methods, Fluid Dynamics & Heat Transfer, & Aeroelasticity

Experimental Approaches & Techniques

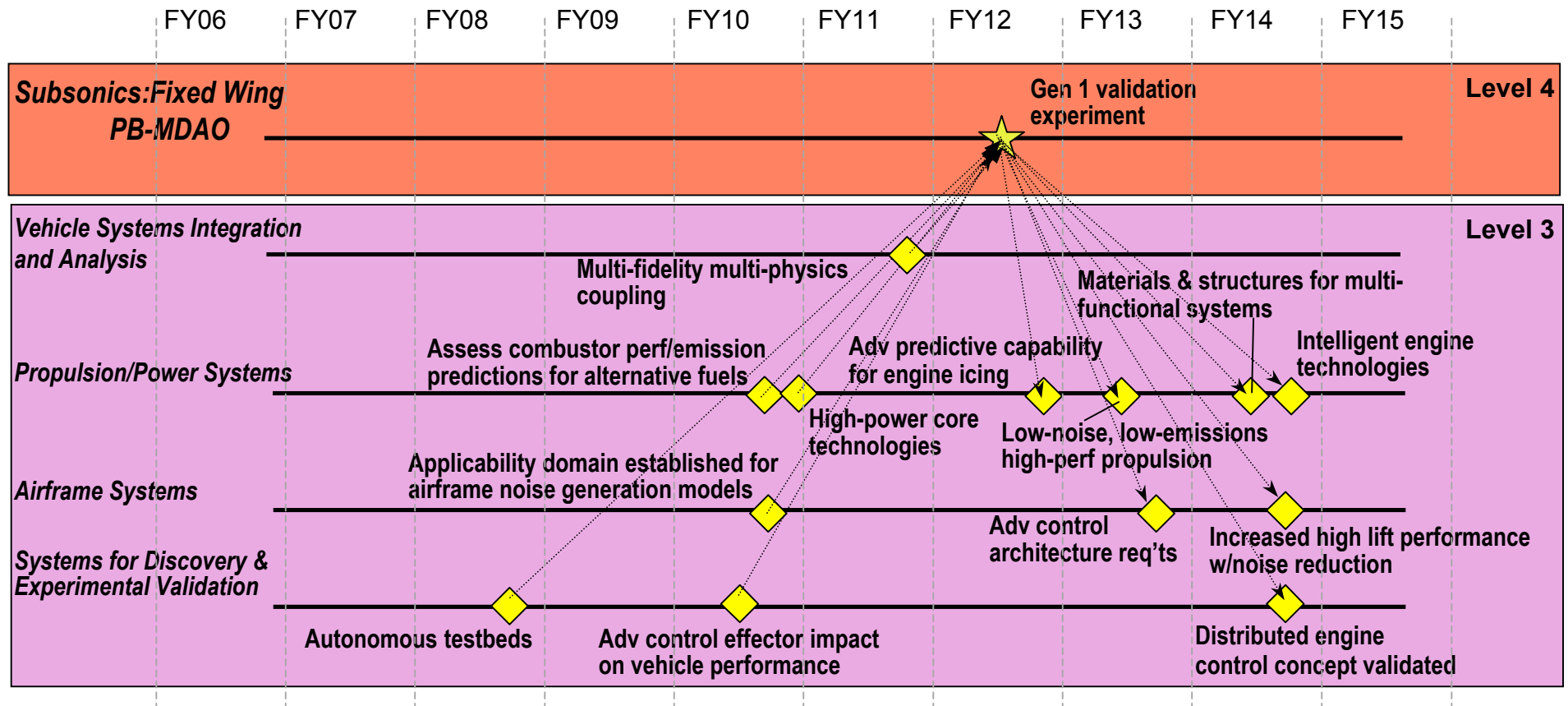


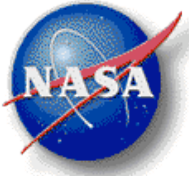
Level 1



Gen 1 Validation Experiment

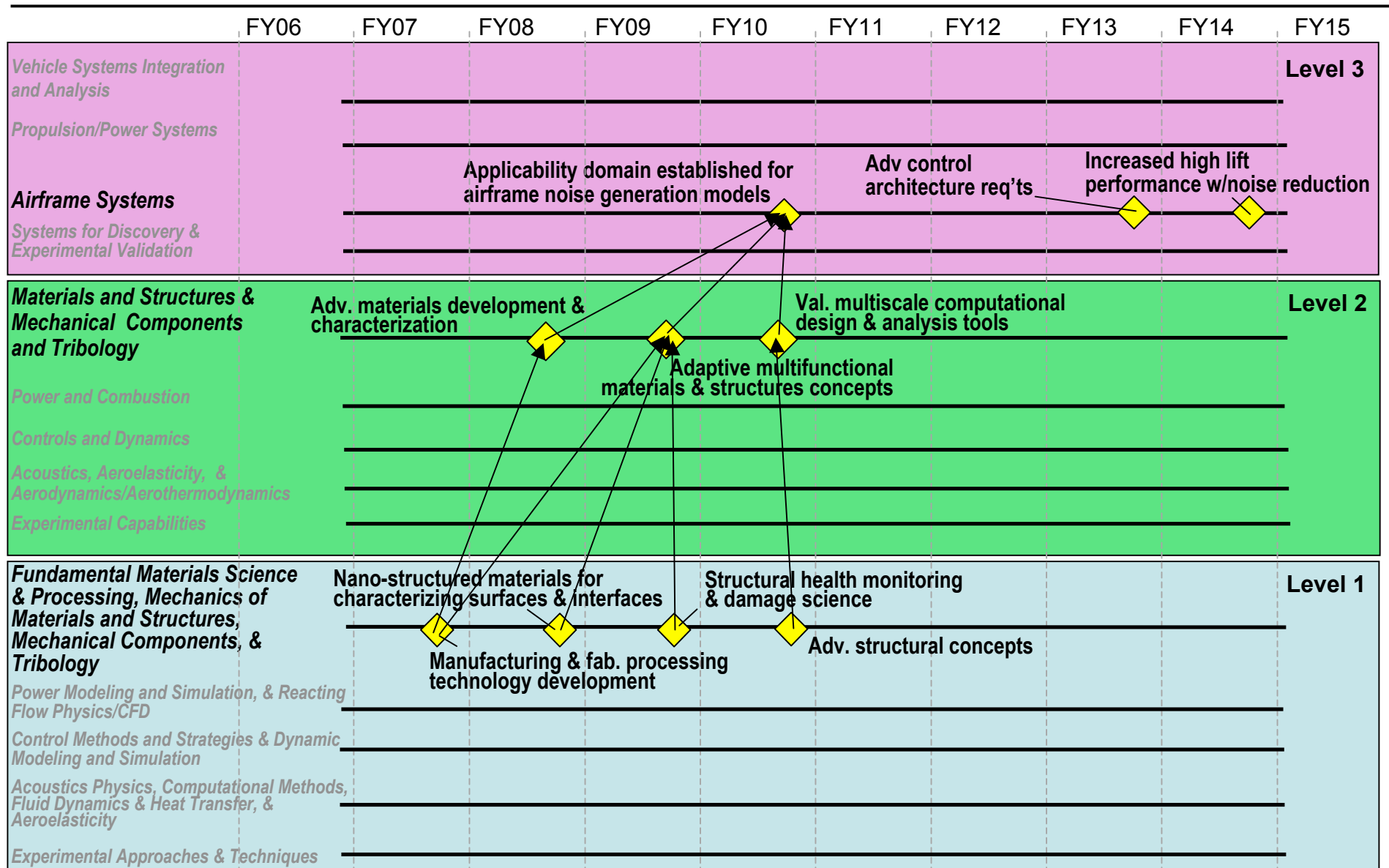
Level 4 Dependencies



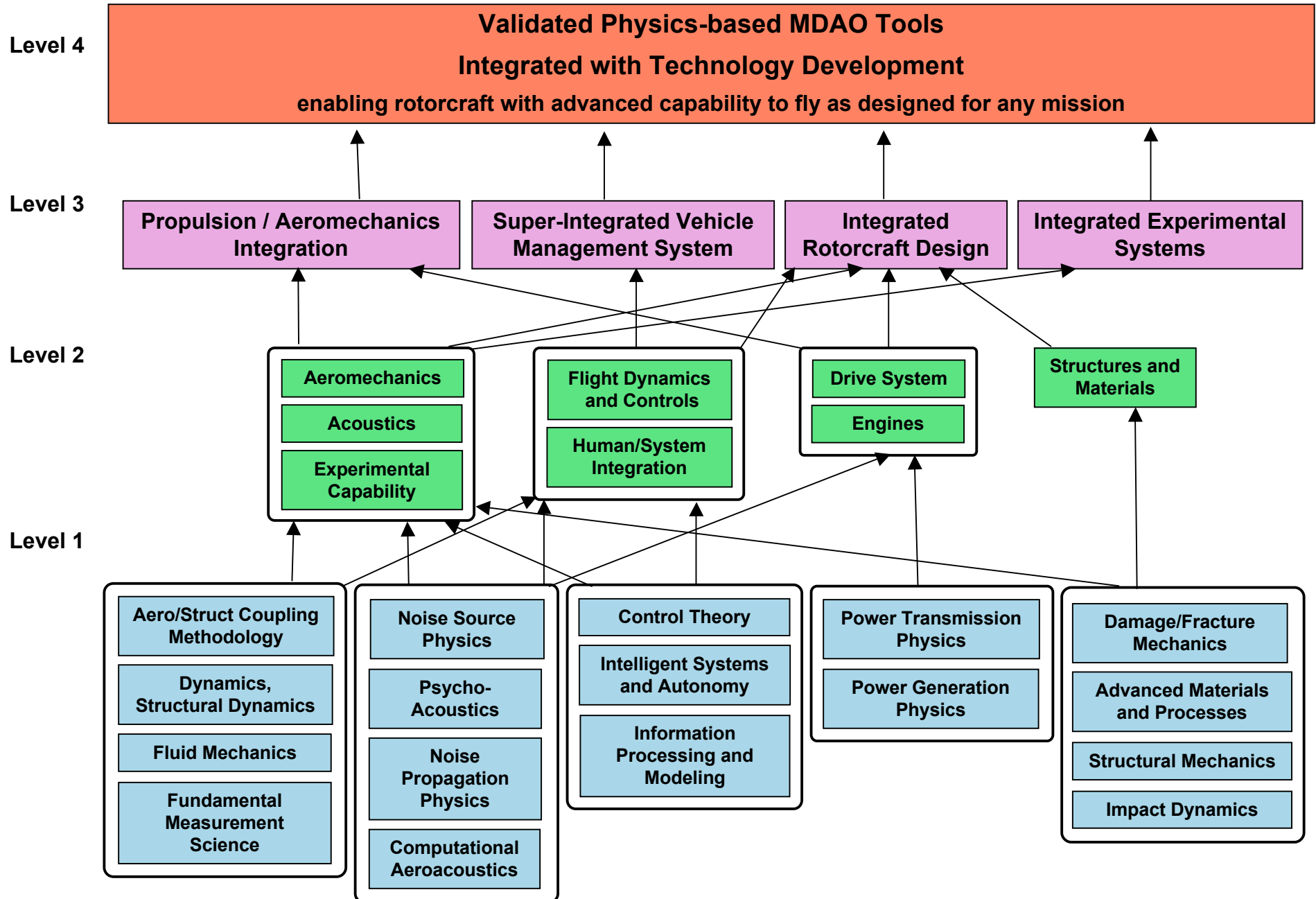


Gen 1 Validation Experiment

Level 3 Dependencies



SUBSONICS: ROTARY WING





Subsonics Rotary Wing: Research Topics

Propulsion-Aeromechanics Integration	Variable speed drive systems
	Minimal or no-lubricant transmission concepts
	Life extension component technologies
	Alternative engine designs to address on-condition health management and interior noise
Super-Integrated Health Management System	Simulations and flight test to validate investigative results of active-control techniques
	Adaptive displays to address control system design capabilities
Integrated Rotorcraft Design	Aeromechanics and aeroacoustics predictive design capabilities for various size and flight regime operations
Integrated Experimental Systems	Methodology for real-time comparison of computational fluid- and structural-dynamics with experimental data
	Integrated diagnostic instrumentation systems into facilities for operational efficiency
	Simultaneous, multi-parameter diagnostic techniques that enable rapid testing and validation of rotorcraft behavior

FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15

Subsonics:Rotary Wing

*Design for any mission; Fly as designed;
Design for advanced capability,
including tools and technologies*

Validated PB-MDAO Capability

Improve prediction accuracy for existing rotorcraft behavior. Refine research focus.

Demonstrate progress toward validating predictive capability for adv rotorcraft & expanded operating conditions

Level 4

Propulsion/Aeromechanics Integration

Super-Integrated Vehicle Management System

Integrated Rotorcraft Design

Integrated Experimental Systems

Level 3

Drive System, Engines

Flight Dynamics and Controls, Human/System Integration

Aeromechanics, Acoustics

Structures/Materials, Experimental Capabilities for Component Evaluation

Level 2

Power Transmission Physics, Power Generation Physics

Control Theory, Intelligent/Autonomous Systems,Human Performance/Modeling

Solid Mechanics, Advanced Materials

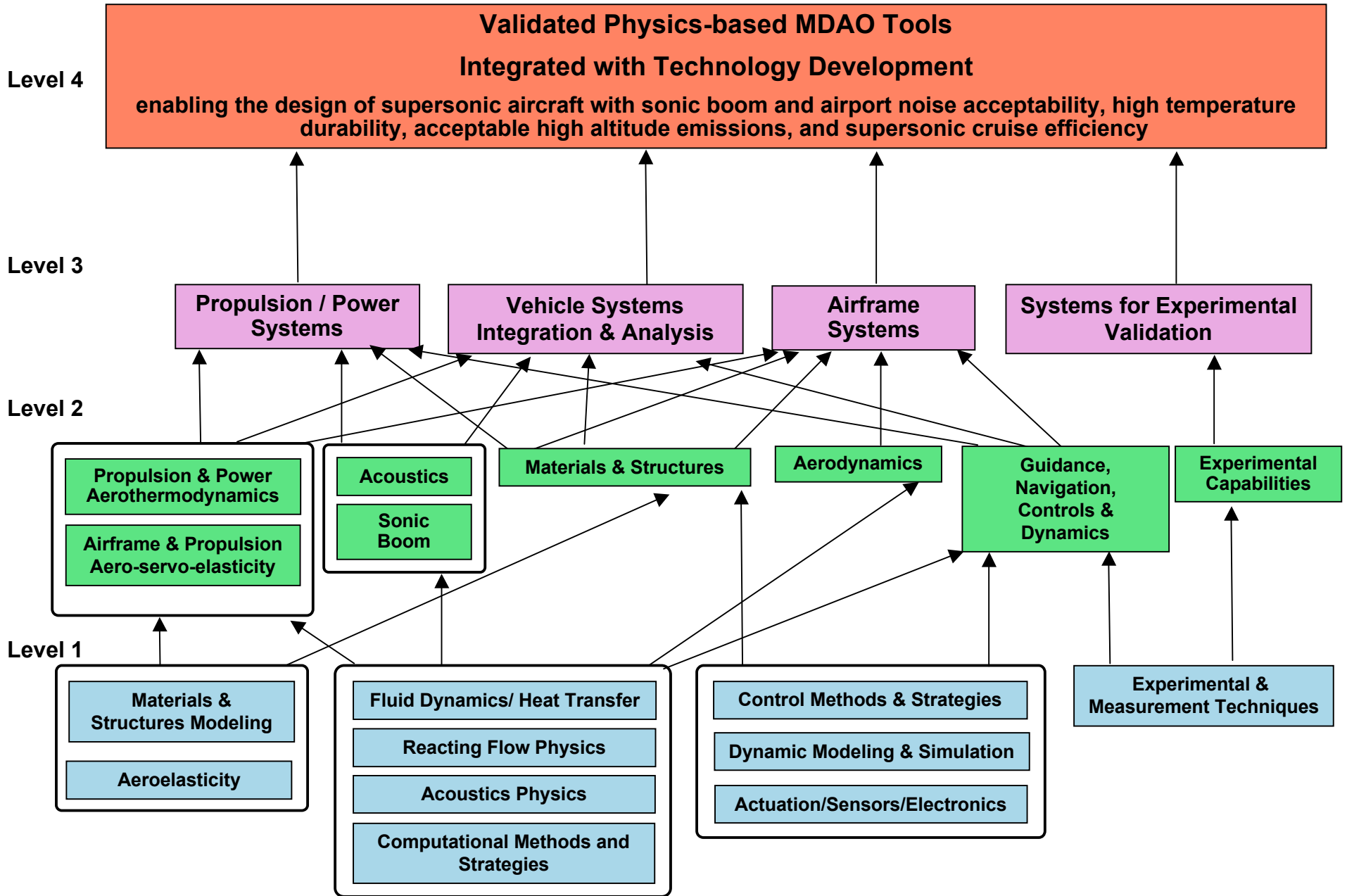
Fluid Mechanics, Dynamics, Aero/Structural Coupling

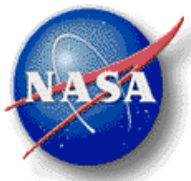
Acoustics Physics

Fundamental Measurement Science

Level 1

SUPERSONICS





Supersonics Research Topics

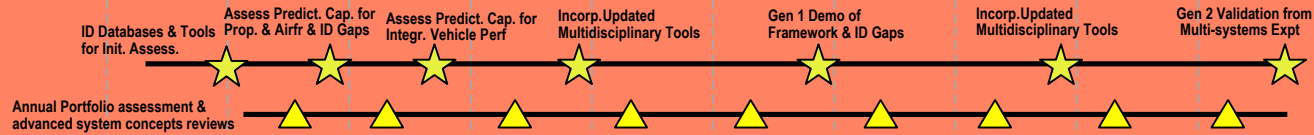
Propulsion and Power Systems	Tools to predict propulsion system noise, efficiency and high altitude emissions
	Reduced emissions combustor predictive capability
	Variable geometry nozzle aerodynamic predictive capability
	Multi-fidelity engine-aircraft structural simulation
	Ice accretion prediction
	High-pressure recovery predictive capability
Vehicle Systems Integration and Analysis	Low distortion and unstart mitigation inlets, integrated inlet-fan-nozzle predictive capability for steady-state and transient conditions
	Tools to predict integrated vehicle performance, noise and sonic boom, installed propulsion system noise-performance trades for supersonic propulsion cycles, and integrated inlet-fan-nozzle
Airframe Systems	Tools to predict airframe noise, lift-drag, flight dynamics, stability and handling qualities
	High-fidelity computation method for achieving simultaneous gust and maneuver loads, ride quality due to elasticity, and flutter suppression control
Systems for Experimental Validation	Systems for experimental validation of capabilities for field noise measurements and techniques
	Requirements for national facilities to support propulsion and airframe systems tests

FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15

PB-MDAO for Supersonic Aircraft

Supersonics

Quantified Uncertainty
Known Sensitivities



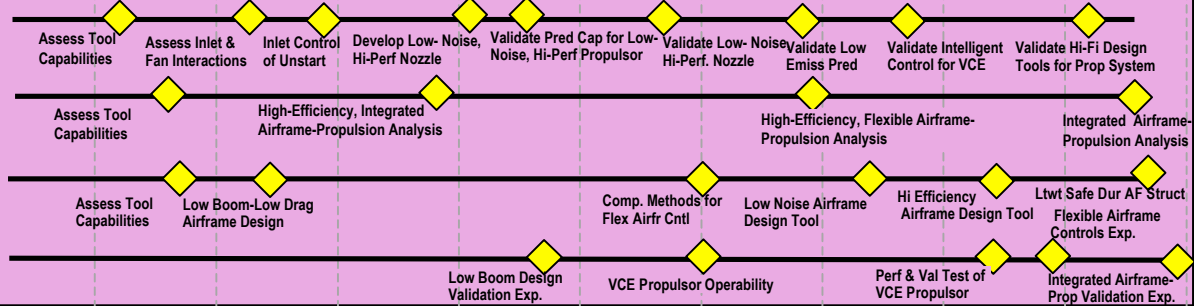
Level 4

Propulsion/Power Systems

Vehicle Systems Integration and Analysis

Airframe Systems

Systems for Experimental Validation



Level 3

Propulsion/Power; Aero-Servo-Elasticity

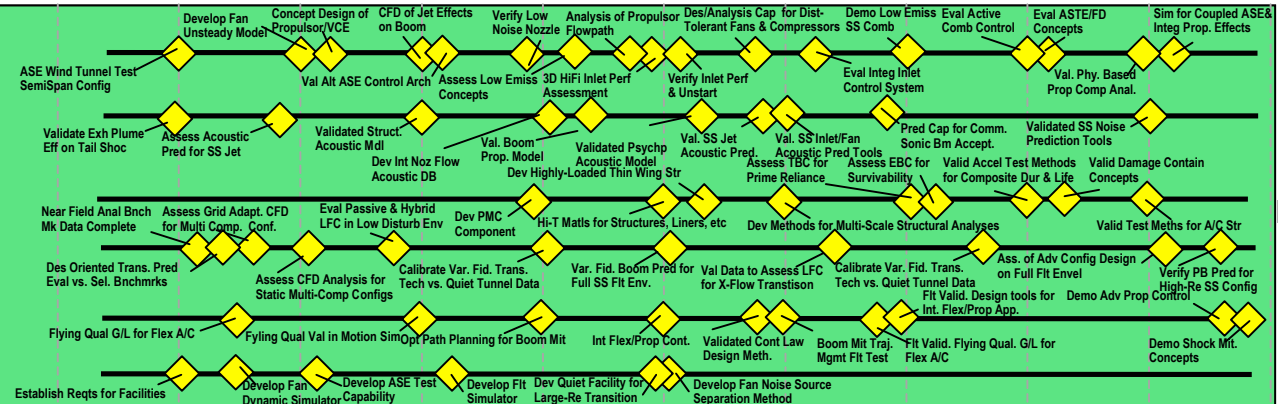
Acoustics & Sonic Boom

Materials & Structures

Aerodynamics

Guidance, Navigation, Controls & Dynamics

Experimental Capabilities



Level 2

Materials & Structures Modeling; Aeroelasticity

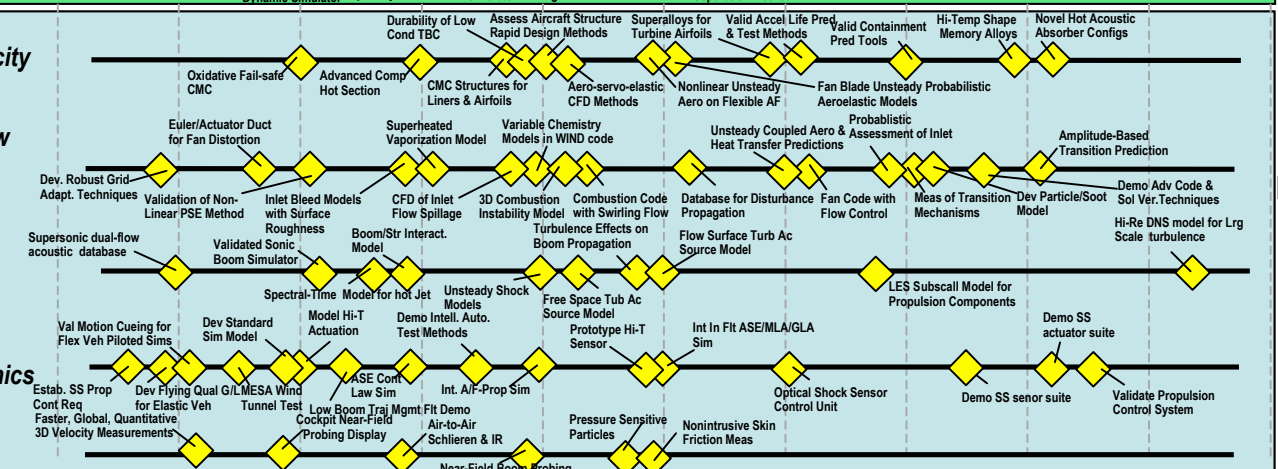
Fluid Dynamics/Heat Transfer; Reacting Flow Physics; Computational Methods/Strategies

Acoustics Physics

Controls Methods & Strategies; Dynamic

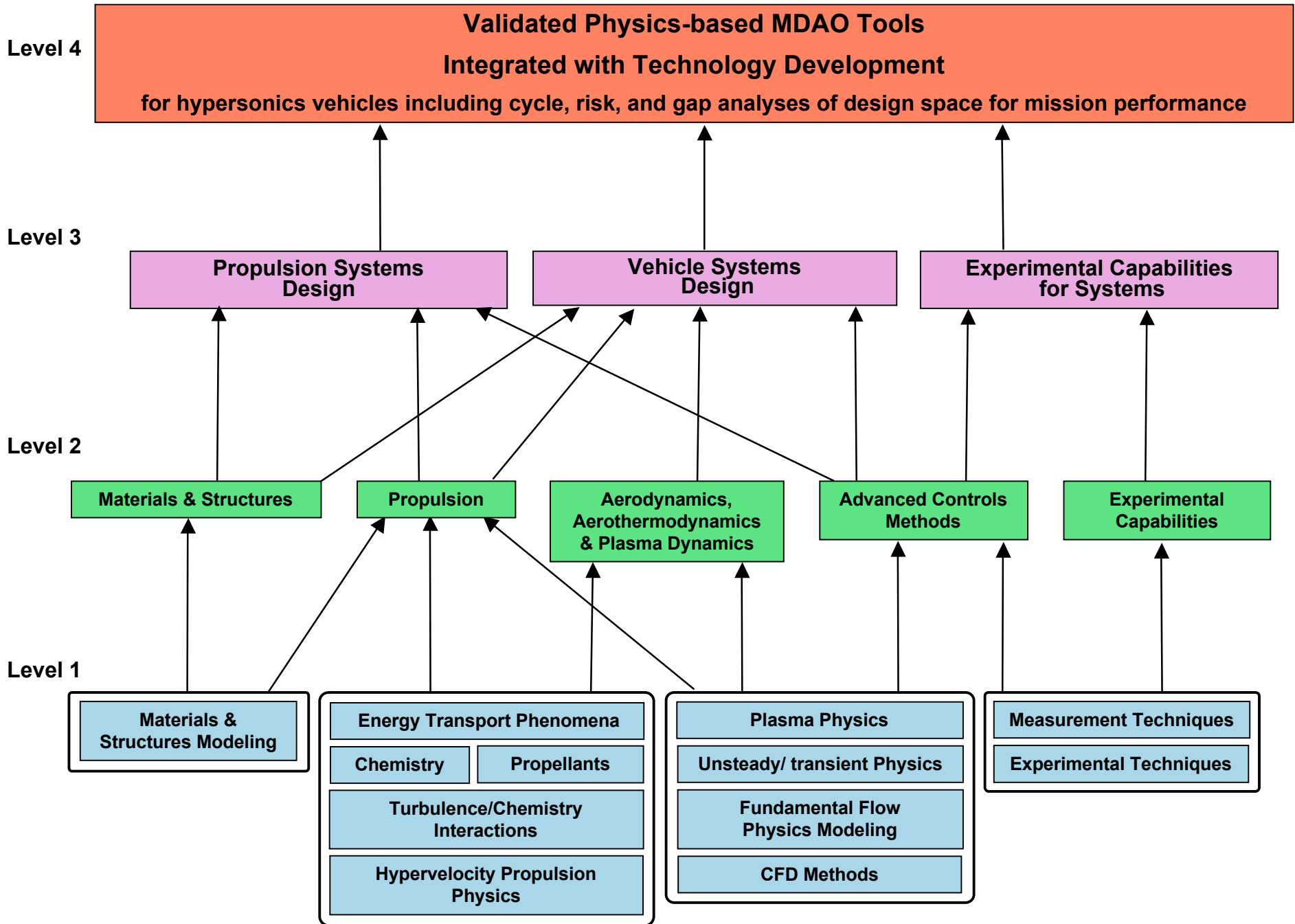
Modeling & Sim; Actuation/Sensors/Electronics

Experimental & Measurement Techniques



Level 1

HYPERSONICS





Hypersonics Research Topics

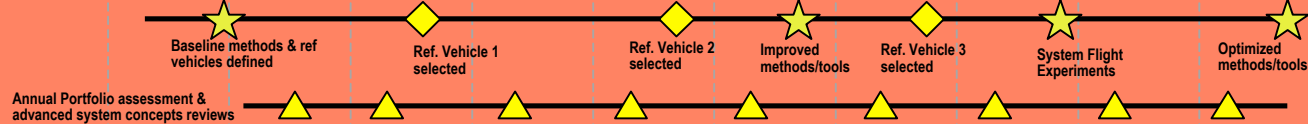
Propulsion Systems Design	Technology development for Turbine Based Combine Cycle (TBCC) and Rocket Based Combined Cycle (RBCC) propulsion systems to aid mode transition between low-speed and high-speed flowpaths, and address engine system thermal management and inlet operability
	Materials for cryogenic tanking applications
Vehicle Systems Design	Technologies to address the physics of combustion, hypersonic flows, and entry, descent and landing
	Lightweight high temperature materials for rotating and static components
	Structural durability analysis methods including deterministic and probabilistic life prediction techniques and non-destructive evaluation
	Material and structure alternatives for vehicle hot structures
	Methods and materials for developing improved thermal protection systems for extreme flight regimes of hypersonic flight
Experimental Capabilities for Systems	Methods for a single extreme environment sensor to measure multiple flow and structural values
	Optical sensors for flow characterization
	Multi-discipline control techniques for health monitoring
	Air data system allowing air-ground communication with the vehicle traveling Mach 12+ along the horizon

FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15

Hypersonics

Vehicle System Designs
Propulsion System Designs
Experimental Flight Test

PB-MDAO Life Cycle, Risk, and Gap Analyses of Design Space for Mission Performance

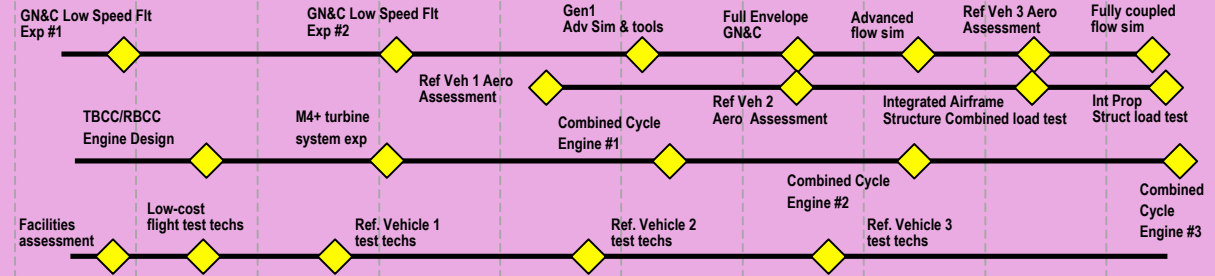


Level 4

Vehicle System Designs

Propulsion System Designs

Experimental Capabilities
for System Design Validation



Level 3

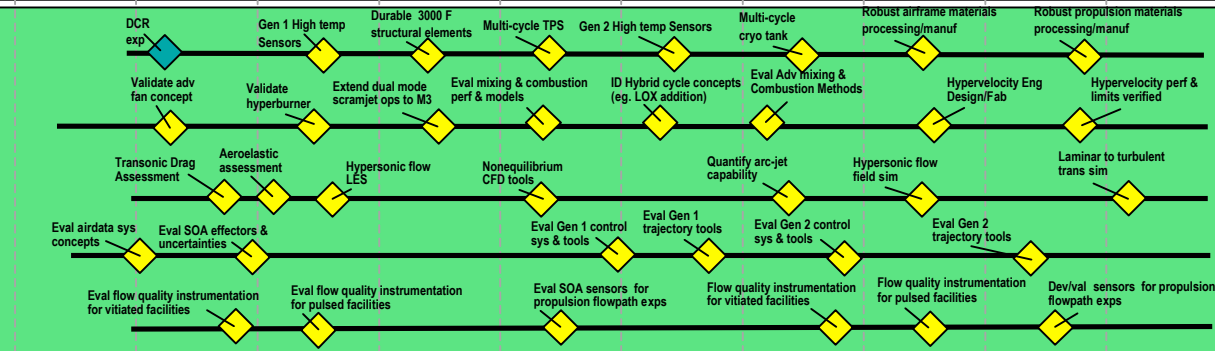
Materials and Structures

Propulsion

Aero/Aerothermo/Plasma Dynamics

Advanced Controls

Experimental Capabilities for
Components & Facilities Testing



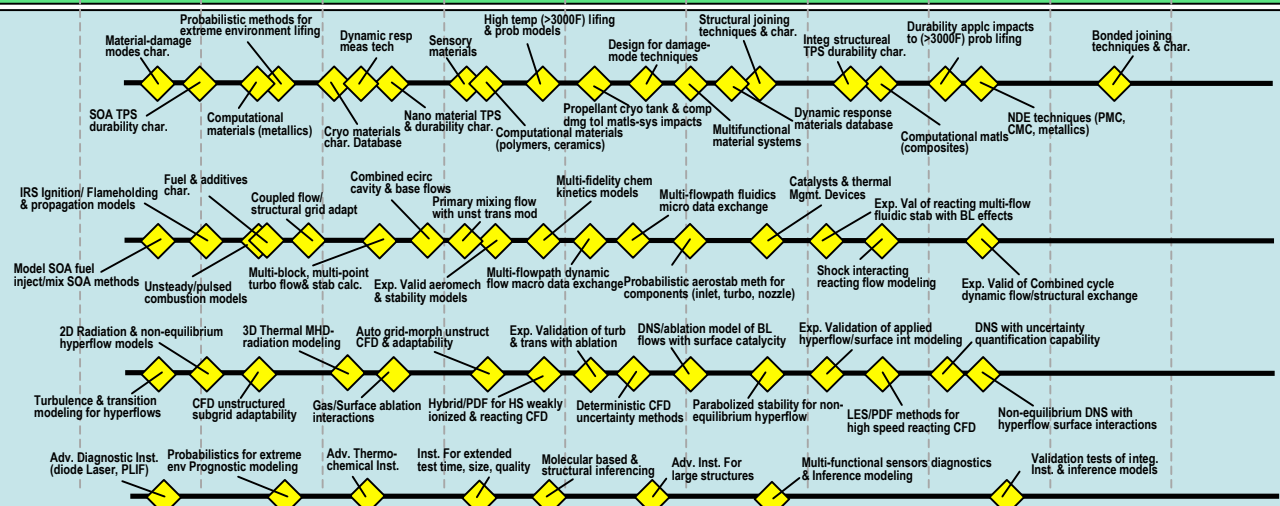
Level 2

Materials & Structures Modeling

Propulsion Physics Modeling

Aerodynamics, Aerothermodynamics,
Plasma Dynamics Methods Development

Experimental Measurement/Techniques



Level 1

Fundamental Aeronautics

Fundamental Aeronautics Office

Dr. Richard Wlezien, Program Director (Acting)

Mr. Herbert Schlickemaier, Deputy Program Director (Acting)

Subsonic Fixed Wing Program

Dr. Fayette Collier, Principal Investigator

Mr. Eddie Zavala, Program Manager

Mr. Dennis Huff, Program Scientist

Subsonic Rotary Wing Program

Ms. Susan Gorton, Principal Investigator

Dr. Gloria Yamauchi, Program Manager

Dr. Wayne Johnson, Program Scientist

Mr. James Zakrajsek, Program Scientist

Supersonics Program

Mr. Peter Coen, Principal Investigator

Ms. MaryJo Long-Davis, Program Manager

Dr. Lou Povinelli, Program Scientist

Hypersonics Program

Mr. Randall Volland, Principal Investigator

Dr. Paul Bartolotta, Program Manager

Dr. Naji Mansour, Program Scientist